



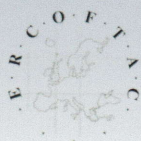
XXIII Fluid Mechanics Conference 2018

BOOK OF ABSTRACTS



9-12.09.2018 Zawiercie, Poland

Honorary Patronage



Ministry of Science
and Higher Education
Republic of Poland



ISBN: 978-83-951800-0-2

XXIII FLUID MECHANICS CONFERENCE

BOOK OF ABSTRACTS

Editors:

Witold Elsner, Renata Gnatowska, Maciej Marek, Artur Drózd

Zawiercie, Poland, 9–12 September 2018

ORGANISING COMMITTEE ADDRESS

Czestochowa University of Technology
Faculty of Mechanical Engineering and Computer Science
“XXIII Fluid Mechanics Conference”
al. Armii Krajowej 21
42-201 Czestochowa, Poland
email: kkmp2018@wimii.pcz.pl

All rights reserved. No part of this book may be reproduced,
stored in a retrieval system, or transmitted in any form or by any means, without the prior permission
in writing of the Publisher.

The book has been printed in camera ready form

© Copyright by Czestochowa University of Technology, al. Armii Krajowej 21
42-201 Czestochowa, Poland

*The short papers have been produced from the electronic materials supplied by Authors without
amendments by Editors*

*Organisation of XXIII Fluid Mechanics Conference FMC 2018 is supported financially by Minister of
Science and Higher Education under contract no. 805/P-DUN/2018*

CONTENTS

Preface.....	18
A Remembrance of Prof. Jacek Rokicki.....	20
INVITED LECTURES – ABSTRACTS.....	22
<u>Erik Dick, Sławomir Kubacki, Transition Models for Turbomachinery Boundary Layer Flows.....</u>	<u>24</u>
<u>Franck Nicoud, Rodrigo Mendez, Dorian Midou, Thomas Puiseux, Julien Sigenza, Pierre Taronat, Simon Mendez, Challenges in microscopic and macroscopic blood flows.....</u>	<u>26</u>
<u>Maciej Opoka, CFD Support during Multistage-Axial Compressor Design.....</u>	<u>28</u>
<u>Dongfang Yun, Diego Ayala, Bartosz Protas, Extreme Vortex States and the Hydrodynamic Blow-Up Problem.....</u>	<u>30</u>
<u>Philipp Schlatter, Large-scale simulations of complex turbulent flows using high-order methods.....</u>	<u>32</u>
<u>Luc Vervisch, Pascale Domingo, Guido Lodato, Numerical simulation of flames and turbulent combustion modeling.....</u>	<u>34</u>
<u>Stephane Zaleski, The Simulation of Multiphase Flow.....</u>	<u>36</u>
ABSTRACTS OF THE CONFERENCE PRESENTATIONS.....	38
<u>Emmanuel O. Akinlabi, Marta Waclawczyk, Szymon P. Malinowski, Fractal reconstruction of sub-grid scales in large eddy simulation of atmospheric turbulence.....</u>	<u>40</u>
<u>Rafał Andrzejczyk, Tomasz Muszynski, Experimental and comparative study on the two-phase pressure drop of air-water mixture in U-bend and straight pipe annuli.....</u>	<u>42</u>
<u>Wojciech Aniszewski, S. Zaleski, Y. Saadeh, S. Popinet, Numerical Simulations of Plane Turbulent Jet Stripping of Liquid Coatings.....</u>	<u>44</u>
<u>Dariusz Asendrych, Predicting surface wettability by CFD simulation at flat and textured surfaces.....</u>	<u>46</u>
<u>Dominik Błoński, Henryk Kudela, Fourth-order compact Vortex in Cell implementation for high Reynolds lid-driven cavity problem.....</u>	<u>48</u>
<u>Sławomir Błoński, Piotr Korczyk, Microfluidic systems with rotational symmetry for creating desired concentration distribution of reagents.....</u>	<u>50</u>
<u>Andrzej Bogusławski, Artur Tyliczczak, Karol Wawrzak, Absolute instability of an annular jet - linear stability theory.....</u>	<u>52</u>
<u>Jakub Broniszewski, Janusz Piechna, Simulation of vortex-induced vibrations of a cylinder using overset mesh and fluid-structure interaction approach.....</u>	<u>54</u>
<u>Carla Cotas, Fernando Garcia, Maria Graca Rasteiro, Dariusz Asendrych, Using CFD and EIT to analyse the flow of pulp suspensions.....</u>	<u>56</u>
<u>Zbigniew Czyż, Tomasz Łusiak, Paweł Karpiński, Jacek Czarnigowski, Numerical investigation of the gyroplane longitudinal static stability for the selected stabilizer angles.....</u>	<u>58</u>
<u>Artur Drózdź, Witold Elsner, Dawid Sikorski, Passive Skin Friction Control Near Turbulent Separation - Preliminary Results.....</u>	<u>60</u>
<u>Artur Drózdź, Witold Elsner, Corrected Clauser-Chart Method for a Strong Decelerating Flow.....</u>	<u>62</u>
<u>Stanisław Gęppner, Jerzy Maciej Floryan, Hydrodynamic instabilities in a meandering channel.....</u>	<u>64</u>
<u>Marcin Sosnowski, Renata Gnatowska, Jacek Sobczyk, Waldemar Wodzia, Numerical modelling of flow field within the packed bed of granular material.....</u>	<u>66</u>
<u>Arkadiusz Grucelski, Jacek Pozorski, Thermal dilatation of solid grains: the LBM approach.....</u>	<u>68</u>
<u>Wojciech Gryglas, Application of POD based instrumentation strategy.....</u>	<u>70</u>

Transition Models for Turbomachinery Boundary Layer Flows

Erik Dick¹, Slawomir Kubacki²

¹Department of Flow, Heat and Combustion Mechanics, Ghent University,
St-Pietersnieuwstraat 41, 9000 Ghent, Belgium; *erik.dick@ugent.be*

²Institute of Aeronautics and Applied Mechanics, Warsaw University of Technology,
Nowowiejska 24, 00-665 Warsaw, Poland; *slawomir.kubacki@meil.pw.edu.pl*

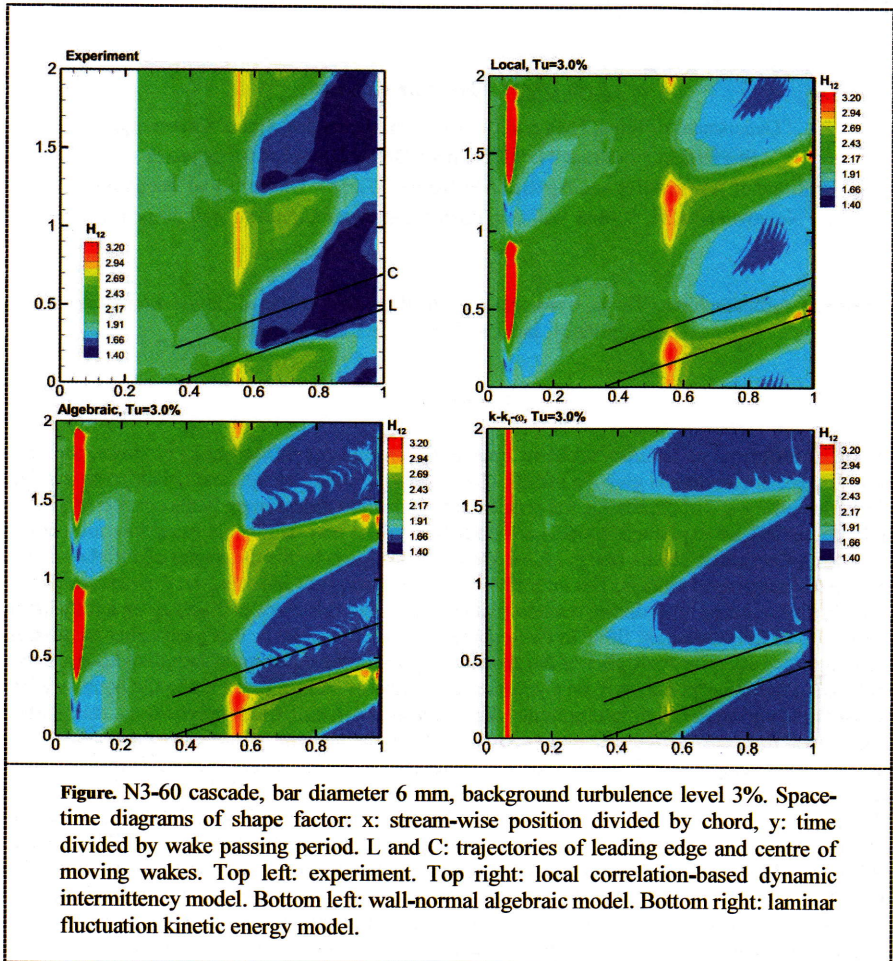
Keywords: turbomachinery flows, transition models, Reynolds-averaged Navier-Stokes equations, intermittency, laminar fluctuation kinetic energy

1. Summary

First, the mechanisms of laminar-turbulent transition, relevant for turbomachinery flows, are briefly discussed. Special attention is given to the effect of impacting wakes by upstream blade rows in relative motion. Then, the ways of expressing the processes by transition model ingredients connected to RANS turbulence models are explained. Models are classified in one way as models using intermittency and models using fluctuation kinetic energy. A second classification is by the categories of correlation-based models and sensor-based models. The intermittency is the fraction of time that the flow is turbulent in a position in the boundary layer during transition. It is a parameter that evolves from zero in a fully laminar flow to unity in fully turbulent flow. In two-equation turbulence models, it is used either as multiplier of the eddy viscosity or as multiplier of the production term in the equation of turbulent kinetic energy. Models using this concept may rely on algebraic description of intermittency along the boundary layer, or across the boundary layer, or intermittency derived from a dynamic transport equation. Intermittency can be derived from correlations, involving boundary layer parameters, in particular the boundary layer momentum thickness, but models using these correlations do not necessary calculate these parameters directly. They may be derived from relevant sensor parameters that, on their turn may be described algebraically or by a dynamic transport equation. The objective is to reach a model that is local, which means that it does not require operations that cross grid partitioning borders in a parallel calculation organisation. The laminar fluctuation kinetic energy is the kinetic energy of non-turbulent fluctuations prior to transition. In models of this type, this kinetic energy is derived from a dynamic transport equation and transition is simulated by transfer to turbulent fluctuation kinetic energy. The transfer may be derived from correlations, but usually it is activated by sensor parameters. Sensor parameters are dimensionless quantities that characterise features of the transition process. In the presentation, we discuss some models of each of the categories.

2. Results

We test relevant models for wake-induced transition by moving wakes impacting on the suction side of a turbine cascade. The figure shows the space-time diagrams of the boundary layer shape factor, obtained by the experiments [1], the local correlation-based intermittency transport model by Menter, Langtry et al., our own wall-normal algebraic intermittency model and the laminar fluctuation kinetic energy model by Walters and Cokljat [2]. In between wake impacts, the initially laminar boundary layer on the suction side becomes turbulent near the trailing edge. Under wake impact, the transition is much earlier. All models capture the earlier transition by wake impact, but there are quantitative differences. We discuss these in the presentation.



Acknowledgement. The second author acknowledges support from a research project COOPERNIK financed partly by the Polish National Centre for Research and Development (INNOLOT/I/11/NCBR/2014) and partly by Avio Polska Sp. z o.o.

References

- [1] Zarzycki R and Elsner E, 2005, The effect of wake parameters on the transitional boundary layer on a turbine blade, *IMEchE J. Power Energy* 219,471-480.
- [2] Dick E and Kubacki S, 2017, Transition models for turbomachinery boundary layer flows: a review, *Int. J. Turbomach. Propuls. Power*, 2,4/1-44.

Index of Authors

- Akinlabi, Emmanuel O., 40
Andrzejczyk, Rafał, 42, 142
Aniszewski, Wojciech, 44
Asendrych, Dariusz, 46, 56
Ayala, Diego, 30
Badur, Janusz, 206, 254
Bartosik, Artur, 84
Bęc, Jarosław, 134
Bibik, Przemysław, 122
Bis, Zbigniew, 102, 248
Błazik-Borowa, Ewa, 134
Błoński, Dominik, 48
Błoński, Sławomir, 50, 106, 246
Bobiński, Tomasz, 98, 176
Bogusławski, Andrzej, 52, 192, 238
Bojar, Zbigniew, 254
Broniszewski, Jakub, 54
Cekus, Dawid, 126
Chrzanowska-Gizyńska, J., 250
Cotas, Carla, 56
Czarnigowski, Jacek, 58
Czyż, Zbigniew, 58
Dick, Erik, 24, 116
Doerffer, Piotr, 162, 216, 220, 236
Domagała, Piotr, 158
Domingo, Pascale, 34
Dorao, Carlos Alberto, 142
Drobnik, Stanisław, 158
Drózd, Artur, 60, 62
Dykas, Sławomir, 198
Elsner, Witold, 60, 62
Firkowski, Mateusz, 230
Flaszyński, Paweł, 162, 216, 236
Floryan, Jerzy Maciej, 64
Fornalik-Wajs, Elżbieta, 120, 164, 182
Garcia, Fernando, 56
Gepner, S. W., 150
Gepner, Stanisław, 64
Gnatowska, Renata, 66, 126
Grabowska, Karolina, 204
Grapow, Filip, 118
Grucelski, Arkadiusz, 68
Gruszka, Konrad, 148
Gryglas, Wojciech, 70
Grzymisławski, Przemysław, 72
Gumowski, Konrad, 74, 100, 156, 242
Hassan, Qusay, 76
Homa, Dorota, 78
Jagodzińska, Idalia, 80, 156
Jamińska-Gadomska, Paulina, 82, 134
Janus, Jakub, 110
Jaszczur, Marek, 76
Jaworska, Beata, 84
Jonak, Paweł, 86, 116
Jójką, Joanna, 88
Jóźwik, Paweł, 254
Kacprzak, Andrzej, 102
Kaczorowska-Ditrich, Katarzyna, 226
Kaczyński, Piotr, 90
Kajzer, Adam, 92
Kalawa, Wojciech, 204
Karpiński, Paweł, 58, 94
Kenjeres, Sasa, 120
Khalaf, Elsayer, 184
Kizilova, Natalya, 96
Klamka, Michał, 98
Klotz, Łukasz, 100
Kobyłecki, Rafał, 102, 248
Kołodziej, Szymon, 132
Kopania, Joanna, 104
Kopec, Jacek M., 136
Korczyk, Piotr M., 50, 106, 246
Kowalewski, T., 250
Koza, Zbigniew, 108
Kozar, Mateusz, 166
Krawczyk, Jerzy, 110
Król, Przemysław, 112
Krusz, Witold, 114
Krzywański, Jarosław, 204
Kubacki, Sławomir, 24, 74, 86, 116